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Development of alginate-based hydrogels/ cryogels by gelation under pressure

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Introduction: A tissue-engineered scaffold should provide suitable macroporous structure similar to that of extracellular matrix which can induce cellular activities and guide tissue regeneration. Hydrogels are biocompatible hydrophilic polymer structures that can imbibe large amounts of water or biological fluids. This work is aimed to present a novel method to fabricate alginate-based calcium cross-linked hydrogels by manipulating gelation at high pressure[1]. The cryogels can be obtained after freeze-drying. Cryogels for biomedical applications are of special interest due to large and highly interconnected pores that provide non-constrained mass transfer for cell growth and proliferation. However, to achieve desirable mechanical properties as well as high adsorption capacity, bimodal meso and macroporous materials are greatly desirable[2,3].

Materials and methods: In this work two freezing regimes were studied in order to convert alginate-based hydrogels into cryogels, namely slow freezing at –80° C and rapid freezing in liquid nitrogen. Finally frozen materials were freeze dried. Hybrid cryogels (1.5 wt% alginate/1.5 wt% biopolymer) with gelatin, gellan gum, carboxymethylcellulose and lignin were prepared. Textural properties of the scaffolds were analyzed by SEM and micro-computed tomography. The mechanical properties of the cryogels were characterized in compression mode (wet and dry state). Finally, cytotoxicity studies by MTS were performed with a L929 cell line.

Results: The results of SEM images indicate that slow freezing (–80 °C) lead to purely macroporous materials, whereas rapid freezing in liquid nitrogen resulted in both meso and macroporous structures (Fig. 1). For instance, in case of alginate/Gelan gum the mean pore size of hybrid cryogels was approximately 190 μm with porosity of 52 %.

The mechanical properties of the cryogels were also characterized in compression mode. Results show that the cryogels have Young's modulus values approx. 1 MPa. Cytotoxicity studies were also carried and none of cryogels prepared present any cytotoxicity.

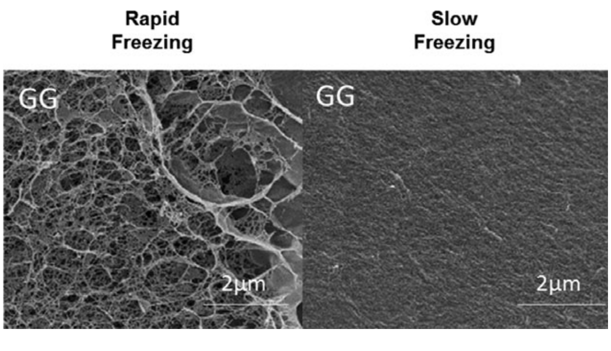

Figure 1. SEM images of alginate/GG cryogels obtained after rapid and slow freezing followed by freeze-drying.

Discussion and conclusions: Hybrid alginate cryogels blended with gelatin, gellan gum, carboxymethylcellulose and lignin were successfully prepared by gelation under pressure. Rapid freezing with subsequent freeze-drying leads to high porosity both in meso and macro range. The results obtained suggest that developed cryogels have, hereafter, the potential to be used for tissue engineering and regenerative medicine.

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